COMPANIONS TO S0 GALAXIES

Barry F. Madore

NASA/IPAC Extragalactic Database

Infrared Processing and Analysis Center

Jet Propulsion Laboratory

California Institute of Technology

Pasadena, CA 91125

e-mail: barry@ipac.caltech.edu

1. INTRODUCTION

Holmberg (1969) presented the first systematic study of the statistical excess of apparent companions around nearby galaxies after examining the environs of 115 northern hemisphere spiral galaxies. He found that on average spirals have one true satellite (and up to as many as five) out to a projected separation of 75 Kpc. Bothun and Sullivan (1977) later undertook to make the same test for 34 (isolated) elliptical galaxies, and found a null result with the frequency of true satellites for this select group of objects being $+0.12 \pm 0.42$ companions per elliptical. The S0 galaxies were not covered in any significant way by either of these pioneering studies. The following is a preliminary report on a study intended to remedy that situation, and to go somewhat further, by attempting to actually identify the individual physical satellites.

2. SO GALAXY COMPANION SURVEY

We have now produced a complete census of 2,759 apparent companions in the vicinity of 130 Shapley-Ames S0 (lenticular) galaxies, covering both the northern and southern hemispheres. '1'lime companions were discovered through a visual inspection of Palomar observatory Sky Survey prints and ESO (Quick Blue) Sky Survey films. All objects projected to within a circular radius of 140 kpc (centered on the SO galaxy) were identified and visually inspected; only those galaxies having metric diameters in excess of 1.0 kpc (when assumed to be at the same distance as the SO galaxy) were then retained for inclusion in the final Catalog (see Figure 3). Revised *Morphological Catalogue of Galaxy* types, visual estimates of relative surface brightness, diameters and axial ratios, were assigned to each companion. Based 011 these attributes, a Morphological Probability Coding (MPC) was also assigned to each apparent companion. This last step allowd us to assign each companion an *a priori* likelihood of being a *physical* companion, based on purely morphological evidence, independent of redshift and/or position with respect to the central galaxy.

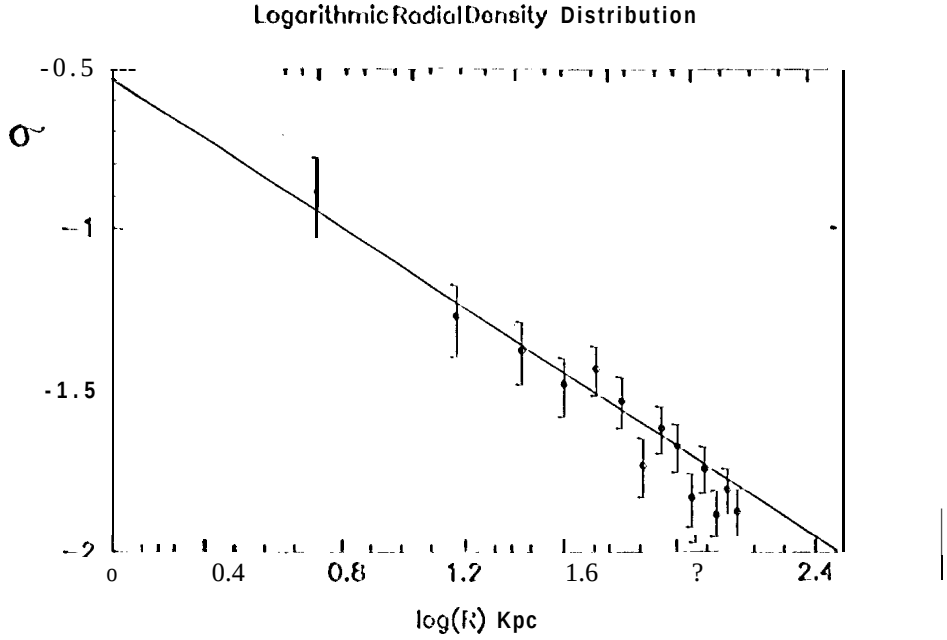

Figure 1 - The radial density distribution of 400 high Probability Code (physical) companions around 130 so galaxies. The solid line has a slope of - 0. 6 corresponding to a correlation function exponent of 1.6.

The radial density distribution of the 2,759 apparent companions reveals a *statistical* excess of (satellite) companions centered on the the parent S0 galaxies. This excess above the field amounts to 569 ± 126 galaxies, where the uncertainty is derived from the $\sqrt{N}$ counting statistics in the last radial bin used to set the field galaxy contamination level. This residual total corresponds to an average of 4.4 physical companions per S0 galaxy within a volume of 0.012 Mpc^3

We believe that it is possible to go beyond the purely statistical description and to formally identify the individual physical companions. Indeed, there are within our Catalog precisely 400 galaxies with Probability Codes > 3 (based on surface brightness and structural considerations) independently indicating that they are likely to be dwarf-type galaxies at the same distance as the central S0. The coincidence of this number with the statistical excess is presumably no accident. While spectroscopic follow-up will ultimately determine the correctness of these identifications we do have other evidence in favor of their being satellites to the central S0 galaxies. For the entire subset of Probability-Code 3 and 4 galaxies their radial density distribution (Figure) shows a striking fall-off from the S0; the Probability-Code 0, 1 and 2 galaxies on the other hand have an essentially flat radial density distribution, (Figure 2) as would be expected for a randomly distributed background field population.

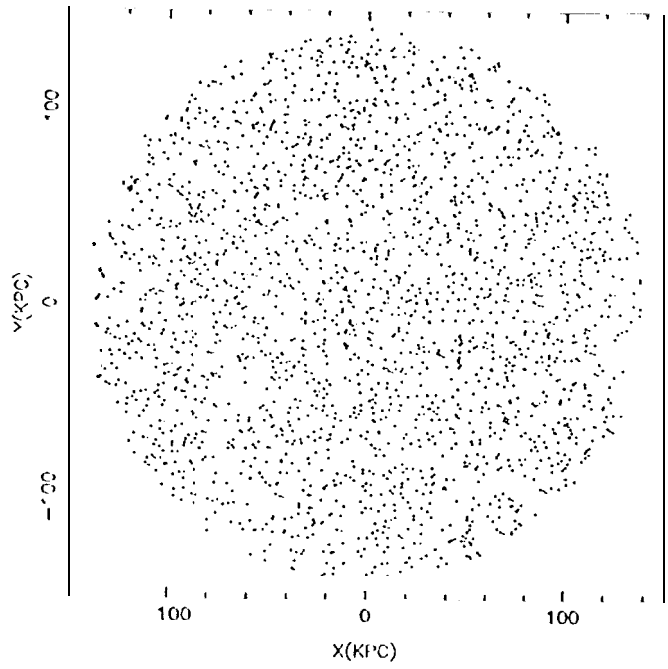

Figure 2 - The areal distribution of 2,359 low Probability Code (field) apparent companions around 130 S0 galaxies. The radial density distribution is essentially flat, consistent with the *a priori* morphological assignment of these galaxies to a predominantly field population.

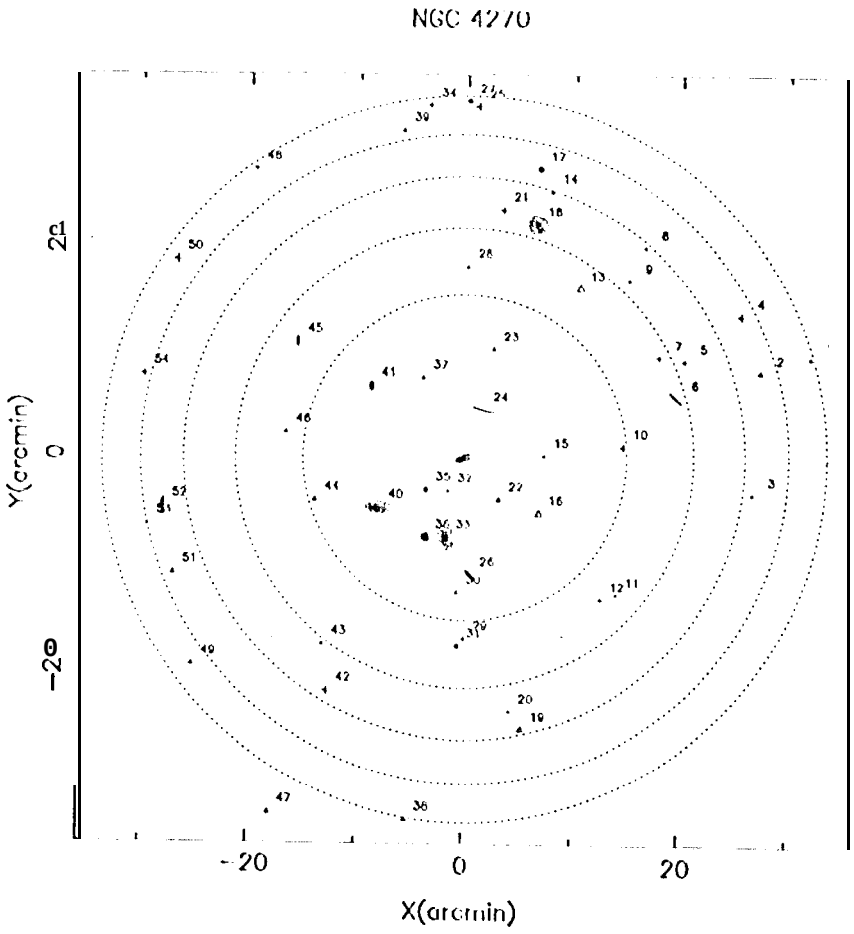

Figure 3 - A n example of one of the figures from the *S0 Companion Catalog* (Madore, 1994) illustrating, in this case, the distribution of apparent companions around the lenticular galaxy NGC 4270.

Acknowledgements

This work was supported in part by the Canada Council, by the NASA/IPAC Extragalactic Database (NED), and by the Jet Propulsion Laboratory, California Institute of Technology, under the sponsorship of the Astrophysics Division of NASA's Office of Space Science and Applications.

Refrences

Bothun, G. D., & Sullivan, W.T. 111, 1977, PASP, 89, 5

Holmberg, E. E. 1969, Ark. Astr., 5, 305